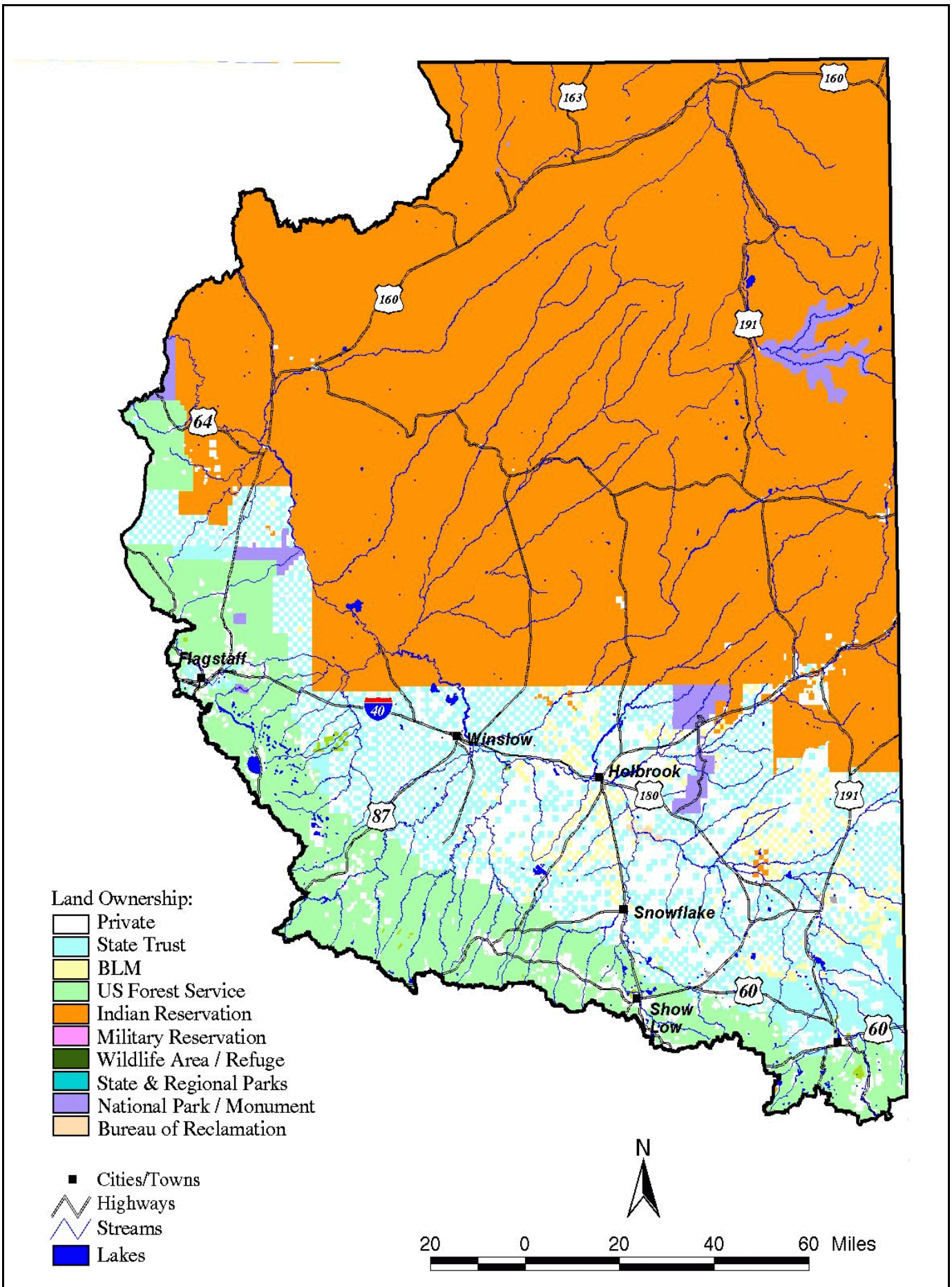
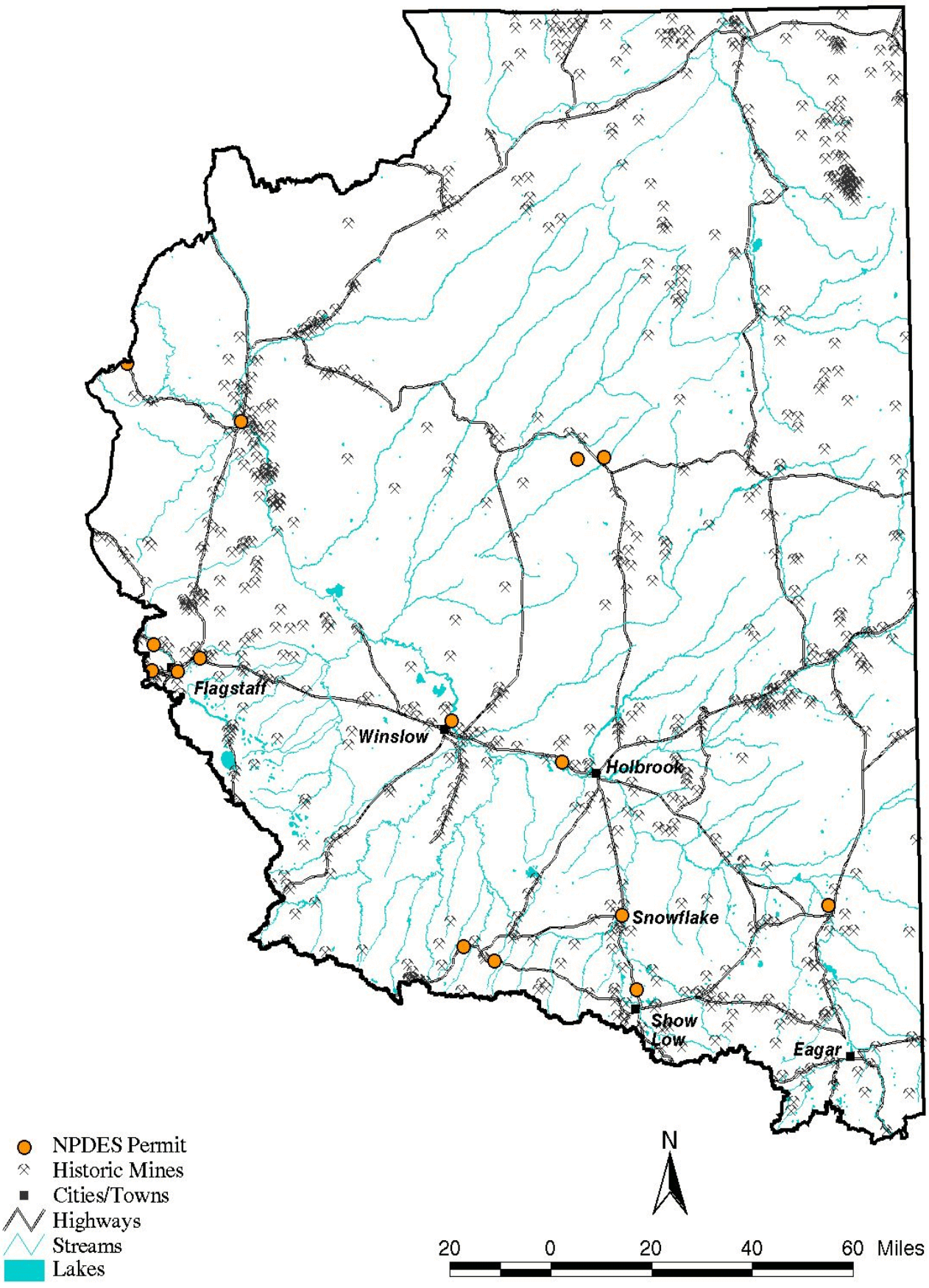
Little Colorado-San Juan Watershed

LITTLE COLORADO - SAN JUAN WATERSHED CHARACTERISTICS

SIZE	26,794 square miles (24% of the State's land area).
POPULATION BASE	Approximately 236,500 people live in this watershed (estimated from the 2000 census). This is about 5% of the state's population.
LAND OWNERSHIP **(Figure 21)**	Tribal land 58% — Private land 16% — US Forest Service 11% State land 8% — Other state and federal land 3.5% — Bureau of Land Management 2% National Parks and Monuments 1.5%
LAND USES AND PERMITS **(Figure 22)**	Flagstaff is the largest community in this watershed. Land use on the non-tribal lands outside of Flagstaff is primarily open grazing, forestry, recreation, and mining. Major communities, tribal land, historic mining, roads and the location of facilities with NPDES discharge permits are illustrated on **Figure 22.** Land and resource preservation and conservation also occur in this watershed with four national monuments, two national forests, and four designated wilderness areas.
HYDROLOGY AND GEOLOGY	This watershed is defined by the Little Colorado River drainage area, from its headwaters to the Colorado River. The flow on the Little Colorado River is interrupted (i.e., stretches of perennial, intermittent, and ephemeral flow) (Brown et al. 1978). Just above Lyman Lake on the Little Colorado River flow varies from no flow to 16,000 cfs (in 1940), with an average annual mean of 23.5 cfs (USGS 1996). Elevations range from 2,700 feet above sea level where the Little Colorado River joins the Colorado River to 12,600 feet at Humphrey's Peak. Horizontally stratified sedimentary rocks have eroded to form canyons and plateaus. The San Francisco Mountains and White Mountains in the Mogollon Rim are igneous rocks deposited on sedimentary formations caused by recent volcanic activity. Ground water basins include: Little Colorado River Basin, with a portion of the Coconino Plateau Basin. The Little Colorado River Basin contains three stratified regional aquifers of poor water quality. The regional aquifers saturate the sedimentary formations of sandstones and limestones separated by shale and siltstone. Local aquifers are an important water source for domestic use and exist in alluvial deposits, sedimentary, and volcanic portions of the Bidahochi Formation, and various sandstones (ADWR 1994). This watershed is contained within the Plateau Highlands Hydrologic Province
UNIQUE WATERS	Lee Valley Creek, from its headwaters to Lee Valley Reservoir.
ECOREGIONS	Primarily Arizona-New Mexico Plateau, with western and southern edges in Arizona-New Mexico Mountains, and the northern fringe in Colorado Plateau.
OTHER STATES, NATIONS, OR TRIBES	This assessment does not reflect water quality on the Navajo, Hopi, and Zuni tribal lands within this watershed **(Figure 21)**. This watershed receives drainage from Utah to the north, New Mexico to the east, and Colorado to the northeast.


Land Ownership:
Private
State Trust
BLM
US Forest Service
Indian Reservation
Military Reservation
Wildlife Area / Refuge
State & Regional Parks
National Park / Monument
Bureau of Reclamation
Cities/Towns
Highways
Streams
Lakes
Flagstaff
Winslow
Holbrook
Snowflake
Show Low
160
163
160
191
64
40
87
180
191
60
60
N
20 0 20 40 60 Miles


Flagstaff
Winslow
Holbrook
Snowflake
Show Low
Eagar
NPDES Permit
Historic Mines
Cities/Towns
Highways
Streams
Lakes
N
20 0 20 40 60 Miles

Little Colorado-San Juan Watershed Assessment Discussion

Statistical Summary of Surface Water Assessments

Assessments – For the 2002 assessment, 250 stream miles and 2,005 lake acres were assessed. This was a focus watershed in 2001; however, this was outside the data window used for this assessment (1995-2000). That data will be applied to the next assessment.

Water quality assessment information for the Little Colorado-San Juan Watershed is summarized in the following tables and illustrated on **Figure 23**:

Table 12. Assessments in the Little Colorado-San Juan Watershed – 2002

	STREAMS		LAKES	
	miles	number of segments	acres	number of lakes
ATTAINING	127	9	159	2
INCONCLUSIVE	127	8	1,818	6
IMPAIRED	17	1	0	0
NOT ATTAINING	0	0	111	1
TOTAL ASSESSED	250	16	2,005	7

PERENNIAL SURFACE WATERS ASSESSED		STREAMS		LAKES	
		miles	number of segments	acres	number of lakes
	Assessed	262	17	2,087	9

* Note that streams with significant perennial stretches within the reach assessed were included in the perennial milage although part of the reach may have ephemeral or intermittent flow.

Inconclusive Assessments – Surface waters with some monitoring data, but insufficient data to determine if the water is attaining its uses or impaired, were added to the new Planning List. By the end of the next watershed monitoring cycle (scheduled in 2005), ADEQ expects to monitor most of these reaches so that all designated uses can be assessed during the following assessment cycle.

ADEQ also will be working with USGS and the Arizona Game and Fish Department so that future monitoring will better support Arizona's surface water assessments. Other lakes and streams which lack monitoring data will also be monitored depending on resources and priorities.

Major Stressors – When a surface water is listed as impaired or not attaining its designated uses, the pollutants or suspected pollutants causing the impairment are identified. Only one reach is assessed as impaired in this watershed: the Little Colorado River, from Porter Tank Draw to McDonalds Wash. This reach is impaired due to metals (copper and silver). A TMDL investigation is needed to determine the source of these metals and the contribution due to natural sources.

Rainbow Lake is assessed as not attaining its uses due to nutrient loadings causing occasional fish kills. A nutrient TMDL was approved by EPA in 2000 and is currently being implemented. The lake was added to the Planning List, and monitoring is being scheduled to evaluate the effectiveness of the TMDL implementation strategies.

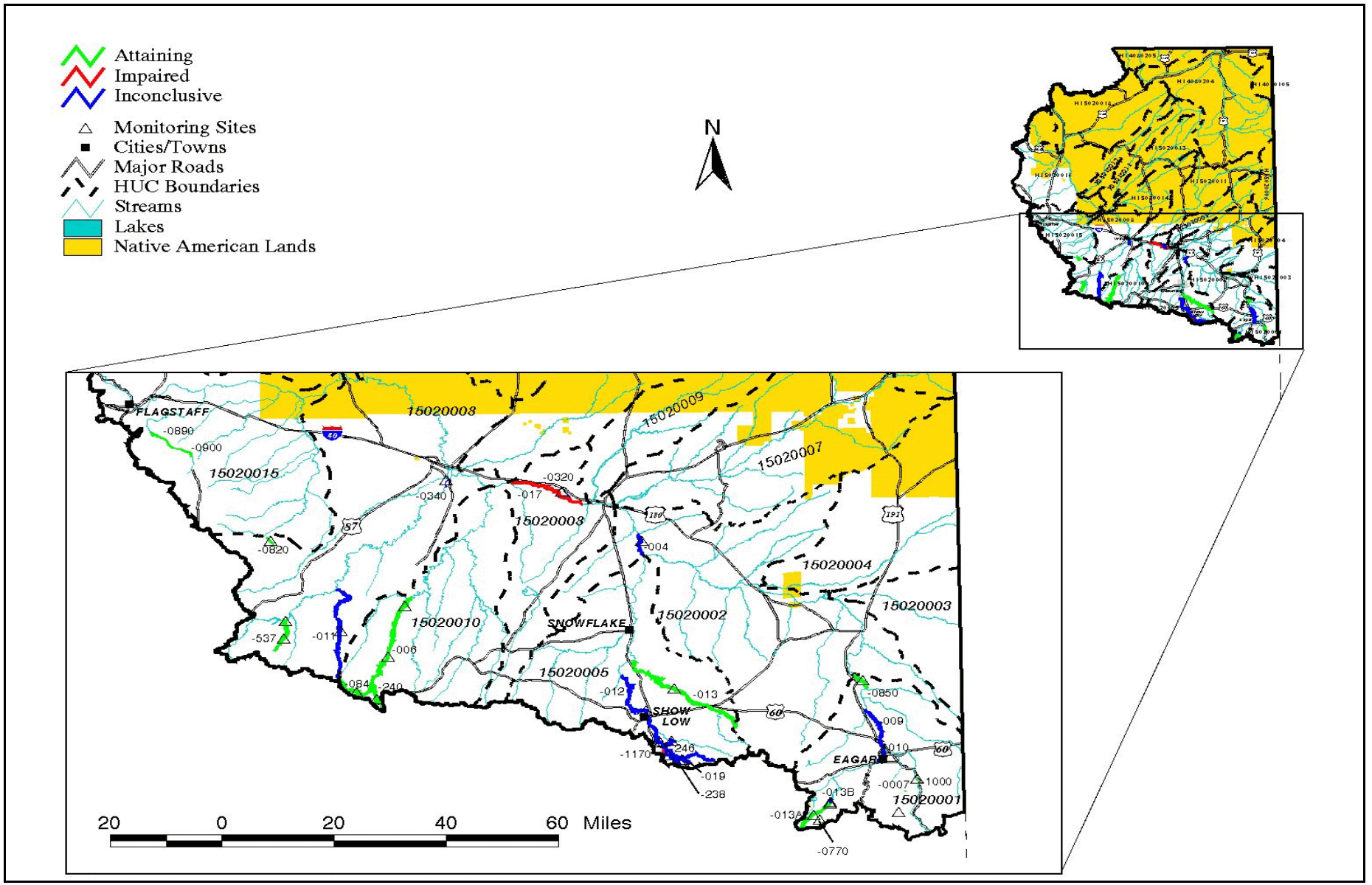


TABLE 13. LITTLE COLORADO - SAN JUAN WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY & PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
STREAM MONITORING DATA								
Barbershop Canyon Creek headwaters-East Clear AZ15020008-537 A&Wc, FC, FBC, AgL	ADEQ Biocriteria Program East Clear Creek confluence LCBRB000.18 100411	1996 - 1 metals 1997 - 1 suite (few metals)	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	6.7	1 of 1		Field staff documented that naturally occurring ground water upwelling rather than any anthropogenic activities caused the low dissolved oxygen; therefore, data not considered in the final assessment. Missing Escherichia coli.
	ADEQ Biocriteria Program At Merritt Draw LCBRB003.84 100410	1997 - 1 suite (few metals)	OK					Missing core parameters: Escherichia coli. (Note no historic or current mining in drainage area so metal samples not required.)
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgL Inconclusive**	**1996-1997** **3 samples** **2 sampling events** **Missing core parameters**	**OK**				**Inconclusive**	**ADEQ's Bioassessment Program collected three water chemistry samples in 1996 - 1997. Assessed as "inconclusive" and placed on the Planning List due to Insufficient sampling events and core parameters monitored.**
Billy Creek headwaters-Show Low Creek AZ15020005-019 A&Wc, FC, FBC, AgL	AGFD Routine Monitoring At hatchery LCBIL002.81	1997 - 1 suite 1998 - 2 suites	OK					Missing core parameters: turbidity and E. coli. (Note no historic or current mining in drainage area so metal samples not required to assess.)
	Summary Row **A&Wc Inconclusive** **FC Attaining** **FBC Inconclusive** **AgL Attaining**	**1998** **3 sampling events** **Missing core parameters**	**OK**				**Attaining**	**AGFD collected three samples in 1998. Assessed as "attaining some uses" and placed on the Planning List due to Insufficient core parameters.**
Buck Springs Canyon Creek headwaters-Leonard Canyon AZ15020008-557 A&Wc, FC, FBC, AgL	ADEQ Biocriteria Program Inside exclosure of cattle and elk LCBCK003.81 100413	1996 - 1 suite	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	3.8	1 of 1		Field staff documented that naturally occurring ground water upwelling rather than any anthropogenic activities caused the low dissolved oxygen; therefore, data not considered in the final assessment.
			pH SU	6.5-9.0 (A&Wc, FBC, AgL)	6.0-6.6	1 of 1		
			Turbidity NTU	10 (A&Wc)	19-27	1 of 1		
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgL Inconclusive**	**1996** **1 sampling event**	**pH SU**	**6.5-9.0 (A&Wc, FBC, AgL)**	**6.0-6.6**	**1 of 1**	**Inconclusive**	**Insufficient monitoring events to assess. Add to Planning List due to pH and turbidity not exceeding standards in one sample.**
			Turbidity NTU	**10 (A&Wc)**	**19-27**	**1 of 1**		
Chevelon Creek headwaters-West Chevelon Creek AZ15020010-006 A&Wc, FC, FBC, AgI, AgL	ADEQ Biocriteria Program At Telephone Ridge LCCHC037.39 100445	1997 - 1 suite	OK					
	AGFD	1996 - 2 field, nutrients	Dissolved oxygen	7.0	6.0-8.3	1 of 6		Lacking turbidity, E. coli, boron, and metals

TABLE 13. LITTLE COLORADO - SAN JUAN WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY & PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	Routine Monitoring @ Chevelon Crossing		mg/L	(90% saturation) (A&Wc)				
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**1996-1997** **3 sampling events** **Missing core parameters**	**Dissolved oxygen mg/L**	**7.0 (90% saturation) (A&Wc)**	**6.0-8.3**	**1 of 6**	**Inconclusive**	**ADEQ and AGFD collected a total of 3 samples at two sites in 1996-1997. Reach assessed as inconclusive" and placed on the Planning List due to insufficient core parameters and dissolved oxygen levels not meeting standards.**
Hall Creek headwaters-Little Colorado River AZ15020001-012 A&Wc, FC, FBC, AgI, AgL	AGFD Routine Monitoring @ Arizona Route 273	2000 - 1 field	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	6.1	1 of 1		
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**2000** **1 sampling event**	**Dissolved oxygen mg/L**	**7.0 (90% saturation) (A&Wc)**	**6.1**	**1 of 1**	**Inconclusive**	**Insufficient sampling events to assess any designated uses. Add to the Planning List.**
Hart Canyon Creek headwaters-Willow Creek AZ15020008-586 A&Wc, FBC, AgL	AGFD Routine Monitoring @ Vincent Ranch	1996 - 1 field, nutrients	OK					
	Summary Row	**1996** **1 sampling event**	**OK**				**Not assessed**	**Insufficient data to assess.**
Little Colorado River West Fork Little Colorado-Water Cyn AZ15020001-011 A&Wc, FC, FBC, AgI, AgL	ADEQ Biocriteria Program Above South Fork LCR LCLCR173.84 100580	1998 - 1 suite	OK					
	Summary Row	**1998** **1 sampling event**	**OK**				**Not assessed**	**Insufficient data to assess.**
Little Colorado River Water Canyon-Nutrioso AZ15020001-010 A&Wc, FC, FBC, AgI, AgL	ADEQ Fixed Station Network At Highway 60 bridge LCLCR172.97 100333	1996 - 6 suites	Turbidity NTU	10 (A&Wc)	10-38	5 of 6		
	Summary Row **A&Wc Inconclusive** **FC Attaining** **FBC Attaining** **AgI Attaining** **AgL Attaining**	**1996** **6 sampling events**	**Turbidity NTU**	**10 (A&Wc)**	**10-38**	**5 of 6**	**Inconclusive**	**ADEQ collected 6 samples in 1996. Reach assessed as "attaining some uses" and was added to the Planning List due to turbidity exceeding standards for further monitoring.**
Little Colorado River Nutrioso Creek.-Carnero Wash AZ15020001-009	ADEQ Fixed Station Below Springerville WWTP LCLCR172.60	1999 - 2 suites + 1 field, nutrients 2000 - 4 suites	Turbidity NTU	10 (A&Wc)	5-45	5 of 7		

TABLE 13. LITTLE COLORADO - SAN JUAN WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY & PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
A&Wc, FC, FBC, AgI, AgL	100331							
	Summary Row **A&Wc Inconclusive** **FC Attaining** **FBC Attaining** **AgI Attaining** **AgL Attaining**	**1999-2000** **4 sampling events**	**Turbidity NTU**	**10 (A&Wc)**	**5-45**	**5 of 7**	**Inconclusive**	**ADEQ collected 4 samples in 1994-2000. Reach assessed as "attaining some uses" and was added to the Planning List due to turbidity exceeding standards for further monitoring.**
Little Colorado River Silver Creek.-Carr Wash AZ15020002-004 A&Ww, FC, FBC, DWS, AgI, AgL	ADEQ Fixed Station Network Near Woodruff LCLCR120.11 100334	1996 - 3 suites + 3 field + 3 nutrients 1999 - 3 suites 2000 - 3 suites	Arsenic (total)	50 (DWS, FBC)	<10 - 67	2 of 12		
			Barium (total) µg/L	2000 (DWS)	170-7,700	1 of 12		
			Beryllium (total) µg/L	0.21 (FC)	1.1-58.2	3 of 3		8 other beryllium samples were not included because Laboratory Reporting Limit was too high
			Beryllium (total) µg/L	4 (FBC)	<0.5-58.2	2 of 12		
			Chromium (total) µg/L	100 (DWS)	<10-200	1 of 16		
			Escherichia coli CFU/100 ml	580 (FBC)	30- 57,000	1 of 7		
			Fecal coliform CFU/100 ml	4,000 (DWS, A & Ww, AgI, AgL)	10 - 28,000	1 of 7		
			Lead (total) µg/L	50 (DWS)	<5-371	2 of 12		
			Lead (total) µg/L	100 (AgL)	<5-371	2 of 12		
			Manganese (total) µg/L	4,900 (DWS)	<50-9,800	2 of 12		
			Nickel (total) µg/L	100 (DWS)	<100-320	2 of 12		
			Turbidity NTU	50 (A&Ww)	30 - 1,000	8 of 11		
	Reach Summary **A&Ww Inconclusive** **FC Attaining** **FBC Inconclusive** **DWS Inconclusive** **AgI Inconclusive**	**1996-2000** **12 sampling events.**	**Arsenic (total) µg/L**	**50 (DWS, FBC)**	**<10 - 67**	**2 of 12**	**Attaining**	**ADEQ collected 12 samples in 1996-2000. Reach is assessed as "attaining some uses" and was added to the Planning List due to beryllium, turbidity, and bacteria exceedances of standards.**
			Barium (total) µg/L	**2000 (DWS)**	**170-7,700**	**1 of 12**	**Attaining**	
			Beryllium (total)	**0.21**	**1.1 - 58.2**	**3 of 3**	**Inconclusive**	

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STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY & PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	AgL Inconclusive		**µg/L**	**(FC)**				
			Beryllium (total) µg/L	**4 (FBC)**	**<0.5-58.2**	**2 of 12**	**Attaining**	
			Chromium (total) µg/L	**100 (DWS)**	**<10-200**	**1 of 16**	**Attaining**	
			Escherichia coli CFU/100 ml	**580 (FBC)**	**30- 57,000**	**1 of 7**	**Inconclusive**	
			Fecal coliform CFU/100 ml	**4,000 (DWS, A&Ww, AgI, AgL)**	**10 - 28,000**	**1 of 7**	**Inconclusive**	
			Lead (total) µg/L	**50 (DWS)**	**<5-371**	**2 of 12**	**Attaining**	
			Lead (total) µg/L	**100 (AgL)**	**<5-371**	**2 of 12**	**Attaining**	
			Manganese (total) µg/L	**4,900 (DWS)**	**<50-9,800**	**2 of 12**	**Attaining**	
			Nickel (total) µg/L	**100 (DWS)**	**<100-320**	**2 of 12**	**Attaining**	
			Turbidity NTU	**50 (A&Ww)**	**30 - 1,000**	**7 of 12**	**Inconclusive**	
Little Colorado River Lyman Lake - unnamed tributary (14 miles) AZ15020002-024 A&Ww, FC, FBC, DWS, AgI, AgL	AGFD Routine Monitoring At Wenima LCLCR158.36	2000 - 1 suite	OK					
	Summary Row	**2000 1 sampling event**	**OK**				**Not assessed**	**Insufficient data to assess.**
Mamie Creek headwaters-Coyote Creek AZ15020001-351 A&Wc, FC, FBC, AgI, AgL	ADEQ Biocriteria Program Below Forest Road 275 LCMAM001.73 100589	1996 - 1 suite	OK					
	Summary Row	**1996 1 sampling event**	**OK**				**Not assessed**	**Insufficient data to assess**
Milky Creek headwaters-Nutrioso Creek AZ15020001-309 A&Wc, FC, FBC	AGFD Routine monitoring Off Nutrioso Creek	1996 - 1 field, nutrients	OK					
	Summary Row	**1996**	**OK**				**Not assessed**	**Insufficient data to assess.**

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			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
		1 sampling event						
Mineral Creek headwaters-Concho AZ15020002-648 A&Wc, FC, FBC, AgI, AgL	ADEQ Biocriteria Program Above Forest Road #404 LCMIN014.01 100593	1996 - 1 suite	OK					
	Summary Row	**1996** **1 sampling event**	**OK**				**Not assessed**	**Insufficient data to assess**
Porter Creek headwaters-Show Low Creek AZ15020005-246 A&Wc, FC, FBC	AGFD Routine Monitoring Above Scott Reservoir LCPRT001.17	1997 - 1 field, nutrients 1998 - 2 field, nutrients	OK					Lack core parameters: turbidity and E. coli. (No historic or current mining in the drainage area, so metals are not required.)
	Summary Row **A&Wc Inconclusive** **FC Attaining** **FBC Inconclusive**	**1997-1998** **3 sampling events** **Missing core parameters**	**OK**				**Attaining**	**AGFD collected 3 samples in 1997-1998. Reach assessed as "attaining some uses" and was placed on the Planning List due to missing core parameters.**
Rudd Creek headwaters-Nutrioso Creek AZ15020001-026 A&Wc, FC, FBC, AgL	ADEQ Biocriteria Program Above Benton Creek LCRUD005.17 100634	1996 - 1 suite	OK					
	Summary Row	**1996** **1 sampling event**	**OK**				**Not assessed**	**Insufficient data to assess**
Show Low Creek headwaters-Linden Wash AZ15020005-012 A&Wc, FC, FBC, AgI, AgL	AGFD Routine Monitoring Above Fools Hollow and below Silver Creek LCSHL010.47	1997 - 1 field, nutrients, metals 1998 - 2 field, nutrients, metals	OK					Lacking core parameters: turbidity, E. coli, and boron. (No current or historic mining in the drainage area so metals are not required).
	AGFD Routine Monitoring Above Show Low Lake	1997 - 1 field, nutrients 1998 - 2 field, nutrients	OK					
	Summary Row **A&Wc Inconclusive** **FC Attaining** **FBC Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**1997-1998** **6 samples** **3 sampling events** **Missing core parameters**	**OK**				**Attaining**	**AGFD collected 6 samples during 1997-1998. Reach assessed as "attaining some uses" and was placed on the Planning List due to missing core parameters.**
Sliver Creek headwaters-Show Low Creek AZ15020005-013	AGFD Routine Monitoring @ Spring	1997 - 1 field, nutrients 1998 - 2 field, nutrients 2000 - 1 suite	OK					Missing core parameters: turbidity, E. coli, boron, metals

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			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
A&Wc, FC, FBC, AgI, AgL	AGFD Routine Monitoring @ Rock House	1997 - 1 field, nutrients 1998 - 2 field, nutrients,	OK					
	AGFD Routine Monitoring @ Upper Springs	2000 - 1 field, nutrients, metals	OK					
	AGFD Routine Monitoring @ U2 Outflow	2000 - 1 field, nutrients, metals	OK					
	AGFD Routine Monitoring @ U3 Outflow	2000 - 1 field, nutrients, metals	OK					
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**2000** **10 samples** **4 sampling events** **Missing core parameters**	**OK**				**Inconclusive**	**AGFD collected a total of 10 samples at 5 sites in 1997-2000. Reach assessed as "inconclusive" and was placed on the Planning List because of missing core parameters.**
South Fork Little Colorado River headwaters-Little Colorado River AZ15020001-027 A&Wc, FC, FBC, AgI, AgL	ADEQ Biocriteria Program Above So Fork Campground LCSLR001.29 100644	1998 - 1 suite	OK					
	Summary Row	**1998** **1 sampling event**	**OK**				**Not assessed**	**Insufficient data to assess.**
Walnut Creek Pine Lake-Rainbow Lake AZ15020005-238 A&Wc, FC, FBC, AgI, AgL	AGFD Routine Monitoring	1997 - 1 field, nutrients, metals 1998 - 2 field, nutrients, 1 metals	OK					Lacking core parameters: turbidity, E. coli, and boron. (No current or historic mining in the drainage area, so metals not required.)
	Summary Row **A&Wc Inconclusive** **FC Attaining** **FBC Inconclusive** **AgL Inconclusive**	**1997-1998** **3 samples** **Missing core parameters**	**OK**				**Attaining**	**AGFD collected a total of 3 samples in 1997-1998. Reach assessed as "attaining some uses" and was placed on the Planning List due to missing core parameters.**
West Fork Little Colorado River headwaters- Government Springs AZ15020001-013A A&Wc, FC, FBC	ADEQ Biocriteria Program Mount Baldy Wilderness LCWLR004.09 100694	1998 - 1 suite	OK					
	ADEQ Biocriteria Program Above Government Springs LCWLR001.08	1998 - 1 suite	OK					

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			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
	100695							
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive**	**1998** **2 samples** **1 sampling event**	**OK**				**Inconclusive**	**ADEQ collected a total of 1 samples at 2 sites in 1998. Reach assessed as "inconclusive"and was placed on the Planning List due to insufficient sampling events.**
West Fork Little Colorado River Gov't Springs-Little Colorado River AZ15020001-013B A&Wc, FC, FBC, AgI, AgL	ADEQ Fixed Station Network At Government Springs LCWLR000.78 100328	1996 - 6 suites 1999 - 4 suites 2000 - 4 suites	Dissolved oxygen mg/L	7.0 mg/L (90% saturation) (A&Wc)	5.0 - 8.7 (80.0 - 97.3 %)	3 of 12		Field staff documented that naturally occurring ground water upwelling rather than any anthropogenic activities caused the low dissolved oxygen; therefore, data not considered in the final assessment.
	Summary Row **A&Wc Attaining** **FC Attaining** **FBC Attaining** **AgI Attaining** **AgL Attaining**	**1996-2000** **14 sampling events**	**OK**				**Attaining**	**ADEQ collected 14 samples between 1996-2000. Reach assessed as "attaining all uses."**
Willow Creek headwaters-East Clear Creek AZ15020008-011 A&Wc, FC, FBC, AgL	AGFD Rountine Monitoring @ Wiggins Crossing LCWLS	1997 - 1 field, nutrients, metals 1998 - 2 field, nutrients, metals	OK					Missing core parameters: turbidity, E. coli, dissolved metals, flow, arsenic, beryllium, mercury, manganese.
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgL Attaining**	**1997-1998** **3 sampling events** **Missing core parameters**	**OK**				**Attaining**	**AGFD collected 3 samples in 1997-1998. Reach assessed as "attaining some uses" and was placed on the Planning List due to missing core parameters.**
Willow Spring Creek headwaters-Chevelon Creek AZ15020010-240 A&Wc, FC, FBC, AgL	AGFD Routine Monitoring Below dam LCWLS003.26	1996 - 2 field, nutrients	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	1.6-5.86	2 of 2		Missing core parameters: turbidity and E. coli. No mining; therefore metals not required.
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgL Inconclusive**	**1996** **2 sampling events** **Missing core parameters**	**OK**				**Inconclusive**	**AGFD collected three samples in 1996. Reach assessed as "inconclusive"and was placed on the Planning List due to Insufficient monitoring events and core parameters.**
Woods Canyon Creek headwaters-Chevelon Creek AZ15020010-084 A&Wc, FC, FBC, AgL	AGFD Routine Monitoring below dam	1996 - 2 field	Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	5.6-6.9	1 of 2		Missing most core parameters.
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgL Inconclusive**	**1996** **2 samples** **Missing core parameters**	**Dissolved oxygen mg/L**	**7.0 (90% saturation) (A&Wc)**	**5.6-6.9**	**1 of 2**	**Inconclusive**	**AGFD collected two field samples in 1996. Reach assessed as "inconclusive"and was placed on the Planning List due to Insufficient monitoring events and core parameters.**
LAKE MONITORING DATA								
Clear Creek Reservoir	AGFD	1999 - 2 field, nutrients,						Lack core parameters: turbidity, E. coli,

TABLE 13. LITTLE COLORADO - SAN JUAN WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY & PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
AZL15020008-0340 A&Wc, FC, FBC, DWS, AgI, AgL	Routine Monitoring 2 sites LCCCR	metals 2000 - 1 field, nutrients, metals						dissolved chromium, beryllium, arsenic fluoride, and barium. Mercury's method detection limit is not low enough to assess Fish Consumption.
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **DWS Inconclusive** **AgI Inconclusive** **AgL Attaining**	**1999-2000** **3 sampling events** **Missing core parameters**	**OK**				**Attaining**	**AGFD collected 3 samples in 1999-2000. Lake assessed as "attaining some uses," and was placed on the Planning List due to missing core parameters.**
Cholla Lake AZL15020008-0320 A&Ww, FC, FBC, AgL	AGFD Routine Monitoring 2 sites LCCHO	1999 - 3 field, nutrients, metals 2000 - 1 field, nutrients, metals	OK					Lack core parameters: turbidity, E. coli, arsenic, and beryllium. Mercury's method detection limit is not low enough to assess Fish Consumption.
	Summary Row **A&Wc Inconclusive** **FC Attaining** **FBC Inconclusive** **AgL Attaining**	**1999-2000** **4 sampling events** **Missing core parameters**	**OK**				**Attaining**	**AGFD collected 4 samples in 1999-2000. Lake assessed as "attaining some uses," and was placed on the Planning List due to missing core parameters.**
Lee Valley Reservoir AZL15020001-0770 A&Wc, FC, FBC, AgI, AgL	AGFD Routine Monitoring LCLEE	1997 - 1 field, nutrients 1998 - 2 field, nutrients 1999 - 1 field, nutrients	pH SU	6.5-9.0 (A&Wc, FBC, AgI) 4.5-9.0 (AgL)	6.3-10.0	2 of 4		Lack of core parameters: turbidity, E. coli, and boron. No mining in the drainage, so metals not required.
	Summary Row **A&Ww Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**1997-1999** **4 sampling events** **Missing core parameters**	**pH SU**	**6.5-9.0 (A&Wc, FBC, AgI) 4.5-9.0 (AgL)**	**6.3-10.0**	**2 of 4**	**Inconclusive**	**AGFD collected 4 samples in 1997-1999. Lake assessed as "inconclusive" and was placed on the Planning List due to missing core parameters and pH exceedances.**
Long Lake (lower) AZL15020008-0820 A&Wc, FC, FBC, AgI, AgL	AGFD Routine Monitoring 2 sites LCLLL	1998 - 3 field, nutrients	OK					Lack of core parameter coverage: turbidity, E. coli, and boron, Lack of seasonal coverage (sampled only in summer months.) No historic or current mining in the drainage area so metals not required.
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**1998** **3 sampling events** **Missing core parameters and seasonal coverage**	**OK**				**Inconclusive**	**AGFD collected 3 samples in 1998. Lake assessed as "inconclusive" and was placed on the Planning List due to missing core parameters and seasonal coverage.**
Lyman Lake AZL15020001-0850 A&Wc, FC, FBC, AgI, AgL	AGFD Routine Monitoring LCLYM	1997 - 1 field + 2 nutrients, metals 1998 - 1 nutrients	OK					Lack core parameter coverage: turbidity, E. coli, and boron, Lack of seasonal coverage (sampled only in summer months.) No historic or current mining in the drainage area so metals not required.
	Summary Row **A&Wc Inconclusive** **FC Inconclusive** **FBC Inconclusive** **AgI Inconclusive** **AgL Inconclusive**	**1997-1998** **3 sampling events** **Missing core parameters and seasonal coverage**	**OK**				**Inconclusive**	**AGFD collected 3 samples in 1997-1998. Lake assessed as "inconclusive" and placed on the Planning List due to missing core parameters and seasonal coverage.**

TABLE 13. LITTLE COLORADO - SAN JUAN WATERSHED -- MONITORING DATA -- 2002 ASSESSMENT

STREAM NAME SEGMENT WATERBODY ID DESIGNATED USES	AGENCY & PROGRAM SITE DESCRIPTION SITE CODE ADEQ DATABASE ID	YEAR SAMPLED NUMBER AND TYPE OF SAMPLES	STANDARDS EXCEEDED AT THIS SITE PER SAMPLING EVENT					
			PARAMETER UNITS	STANDARD (DESIGNATED USE)	RANGE OF RESULTS (MEAN)	FREQUENCY EXCEEDED STANDARD	DESIGNATED USE SUPPORT	COMMENTS
McKay Reservoir AZL15020001-0007 A&Wc, FC, FBC, AgI, AgL	AGFD Routine Monitoring LCMCK	1996 - 1 field	pH SU	6.5-9.0 (A&Wc, FBC, AgI, AgL)	9.4	1 of 1		
			Dissolved oxygen mg/L	7.0 (90% saturation) (A&Wc)	2	1 of 1		
	Summary Row	**1996** **1 sampling event**	**pH SU**	**6.5-9.0 (A&Wc, FBC, AgI, AgL)**	**9.4**	**1 of 1**	**Not assessed**	**Insufficient data to assess. Added to the Planning List due to exceedances.**
			Dissolved oxygen mg/L	**7.0 (90% saturation) (A&Wc)**	**2**	**1 of 1**	**Not assessed**	
Nelson Reservoir AZL15020001-1000 A&Wc FC, FBC, AgI, AgL	AGFD Routine Monitoring LCNEL	1997 - 1 field, nutrients 1998 - 1 field, nutrients						Lacking core parameters: turbidity, E. coli, and boron. No historic or current mining in the drainage, so metals not required.
	Summary Row **A&Wc Inconclusive FC Inconclusive FBC Inconclusive AgI Inconclusive AgL Inconclusive**	**1996 - 1998** **2 sampling events** **Missing core parameters**	**OK**				**Inconclusive**	**AGFD collected 2 samples 1996-1998. Lake assessed as "inconclusive" and added to the Planning List due to insufficient samples and core parameters.**
Pinetop Hatchery AZL15020005-012 A&Wc, FBC, FC, AgI, AgL	AGFD Routine Monitoring LCPIN	1996 - 1 field, nutrients, metals	OK					
	Summary Row	**1996** **1 sampling event**	**OK**				**Not assessed**	**Insufficient data to assess.**
Woods Canyon Lake AZL15020010-1700 A&Wc, FC, FBC, DWS, AgI, AgL	**ADEQ Clean Lakes Program LCWCL**	**1996 - 1 suite**	**pH (low) SU**	**6.5-9.0 (A&Wc, FBC, AgL)**	**6.0-7.1**	**1 of 1**		**Low pH in hypolimnion of lake.**
	Summary Row	**1996** **1 sampling event**	**pH (low) SU**	**6.5-9.0 (A&Wc, FBC, AgL)**	**6.0-7.1**	**1 of 1**	**Not assessed**	**Insufficient data to assess.**

Information for interpreting these Monitoring Tables

- "Segment" designates the beginning and end points of the reach.
- "Waterbody ID" is derived from combining the following: AZ (for streams) or AZL (for lakes) + a US Geological Survey Hydrologic Unit Code + EPA stream reach number or ADEQ lake number.
- "Designated Uses," "Agency," and "Units" (of measurement) abbreviations are defined in Appendix A.
- "Site Code" is an ADEQ derived abbreviation for the surface water basin, stream name or lake name, and the location of the site. For streams, the numbers are the miles upstream from mouth (normally measured as a straight line vector).
- "ADEQ Database ID" -- This is ADEQ's water quality database reference number. If the data is not in this database, no number will be shown.
- "Samples" -- The year and number of water samples is shown. The federal "water year" is used, from October 1st through September 30th, rather than the calendar year. Types of samples:
  - "Suite" indicates that a broad range of chemical constituents were collected and field measurements were taken (normally inorganics, metals, nutrients, and bacteria.) The chemical constituents monitored are not consistent among the many monitoring entities that provided the data. If the suite did not include the core parameters needed to assess a designated use as "attaining," the missing core parameters are indicated.
  - "Field" indicates that only field measurements such as dissolved oxygen, pH, turbidity, and water temperature were collected.
  - If a specific parameter or parametric group (e.g., zinc, metals, bacteria) is named, monitoring was limited to only these parameters
- "Standards Exceeded at this Site per Sampling Event."
  - Although many parameters may be analyzed, only those exceeding a standard are shown. Other parameters were collected.
  - "OK" indicates that no standards were exceeded.
  - The specific standards are shown as a single parameter may have multiple standards depending on the designated uses assigned. (See standards in Appendix C.)
  - "The Range of Results" indicates the minimum and maximum sample results. If the laboratory reported result is "less than the detection limit" or "not detected," a less than (<) value will be shown along with the detection limit (e.g., <0.5 mg/L).
  - A mean, geometric mean, or median will be shown along with the range of results if applicable to the standard or assessment criteria.
- "Comments" include other information used in interpreting the data for assessments, such as evidence that exceedance is solely due to natural conditions, or that the data does not meet the new "credible" data requirements.

- In the “Summary Row” parameter exceedances are combined from multiple sites, and the assessment of each designated use is shown. The overall assessment for the surface water is described in the “Comments” field: “Attaining,” “Not attaining,” “Impaired,” or “ Inconclusive.” See assessment criteria in Chapter III of Volume I.

Ground Water Assessments in the Little Colorado-San Juan Watershed

Major Ground Water Stressors – Monitoring data collected from wells in this watershed between October 1995 - October 2000 are summarized in **Table 14** and illustrated in **Figures 24, 25, and 26**. Of the 38 wells monitored, no wells exceeded Aquifer Water Quality Standards. This is a very small number of wells for this large area **(Figure 24)**

TDS Concentrations -- Water quality can be characterized based on concentrations of Total Dissolved Solids (TDS) **(Figure 25)**. Elevated salinity may limit practical uses of ground water in some areas as TDS over 500 mg/L has an off-flavor (6 of the 21 wells sampled)) and TDS over 1000 mg/L will limit its use for some crops (2 of 21 wells sampled).

Due to salt deposits, salinity can be naturally very high in ground water. Human activities such as mining, irrigated agriculture, and even wastewater disposal practices can also raise the natural level of salinity in ground water.

No TDS water quality standards apply in this watershed, and the elevated levels of TDS do not present a human-health concern for drinking water. The TDS concentration is only used to generally characterize water quality.

Nitrate Concentrations – Water quality can also be characterized by looking at the concentration of nitrates in ground water **(Figure 26)**. In Arizona, naturally occurring nitrate concentrations in ground water are generally below 3 mg/L and concentrations above 5 mg/L may indicate potential anthropogenic sources of nitrate. Among the 36 wells monitored, all nitrate concentrations were below 5 mg/L, indicating high quality water.

When a nitrate concentration exceeds 10 mg/L, Arizona's Aquifer Water Quality Standard has been exceeded. This standard was set to protect human health ,as water with nitrate greater than 10 mg/L may present a health problem for babies and should not be consumed by nursing mothers. No wells exceeded this standard in this watershed; however, efforts should be made to minimize further contamination of ground water by nitrates.

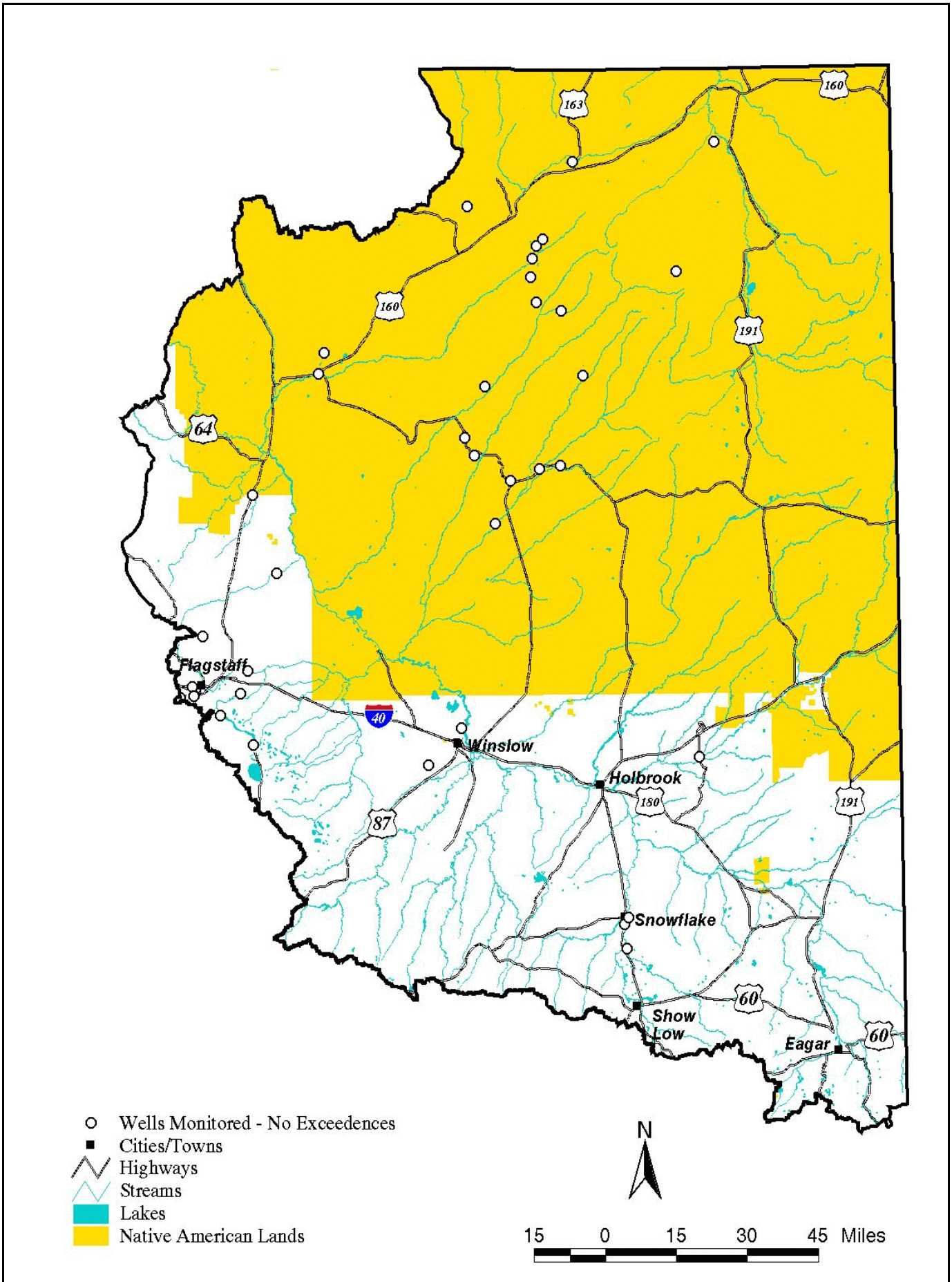
Table 14. Little Colorado-San Juan Watershed Ground Water Monitoring 1996 - 2000

MONITORING DATA TYPE	PARAMETER OR PARAMETER GROUP	NUMBER OF WELLS			PERCENT OF WELLS EXCEEDING STANDARDS
		SAMPLED	SYNTHETIC CONSTITUENT DETECTED*	EXCEEDING STANDARDS	
INDEX WELLS	Radiochemicals	2		0	0%
	Fluoride	3		0	0%
	Metals/Metalloids	3		0	0%
	Nitrate	3		0	0%
	VOCs + SVOCs*	0	–	–	–
	Pesticides	0	–	–	--
TARGETED MONITORING WELLS	Radiochemicals	13		0	0%
	Fluoride	31		0	0%
	Metals/metalloids	32		0	0%
	Nitrate	33		0	0%
	VOCs + SVOCs*	3	0	0	0%
	Pesticides	3	0	0	0%

WELL CLASSIFICATION BY TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION				
Total Number of Wells (all targeted wells)	Wells <500 mg/L Acceptable drinking water flavor	Wells 500-999 mg/L Fresh (not saline) Some crop production problems	Wells 1000-3000 mg/L Slightly saline Increasing crop production problems	Wells >3000 mg/L Moderately saline to briny Severe crop production problems
21	15	4	1	1

WELL CLASSIFICATION BY NITRATE CONCENTRATION (measured as Nitrogen)			
Total Number of Wells (only 3 index wells)	Wells <5 mg/L	Wells 5-10 mg/L May be an anthropogenic source of Nitrates	>10 mg/L Exceeds standards Should not be used for drinking water by babies or nursing mothers
36	36	0	0

*VOCs = volatile organic compounds; SVOCs = semi-volatile organic compounds.
The detection of a synthetic constituent (pesticides, VOCs, and SVOCs) is noted because some do not have standards and these substances are not naturally occurring in the ground water.


160
163
160
191
64
Flagstaff
40
Winslow
Holbrook
180
191
87
Snowflake
60
Show
Low
Eagar
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Wells Monitored - No Exceedences
Cities/Towns
Highways
Streams
Lakes
Native American Lands
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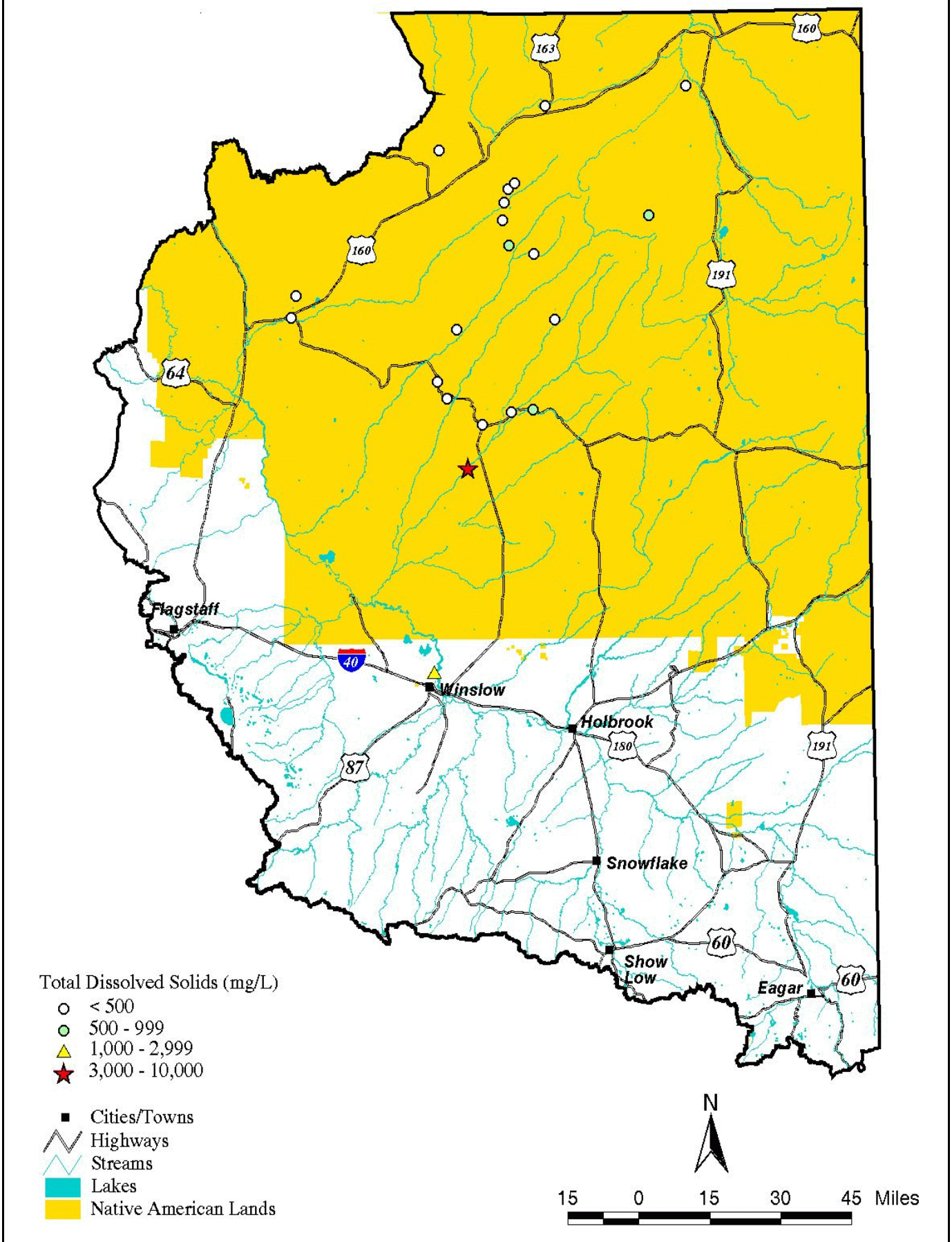
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Eagar
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Total Dissolved Solids (mg/L)
< 500
500 - 999
1,000 - 2,999
3,000 - 10,000
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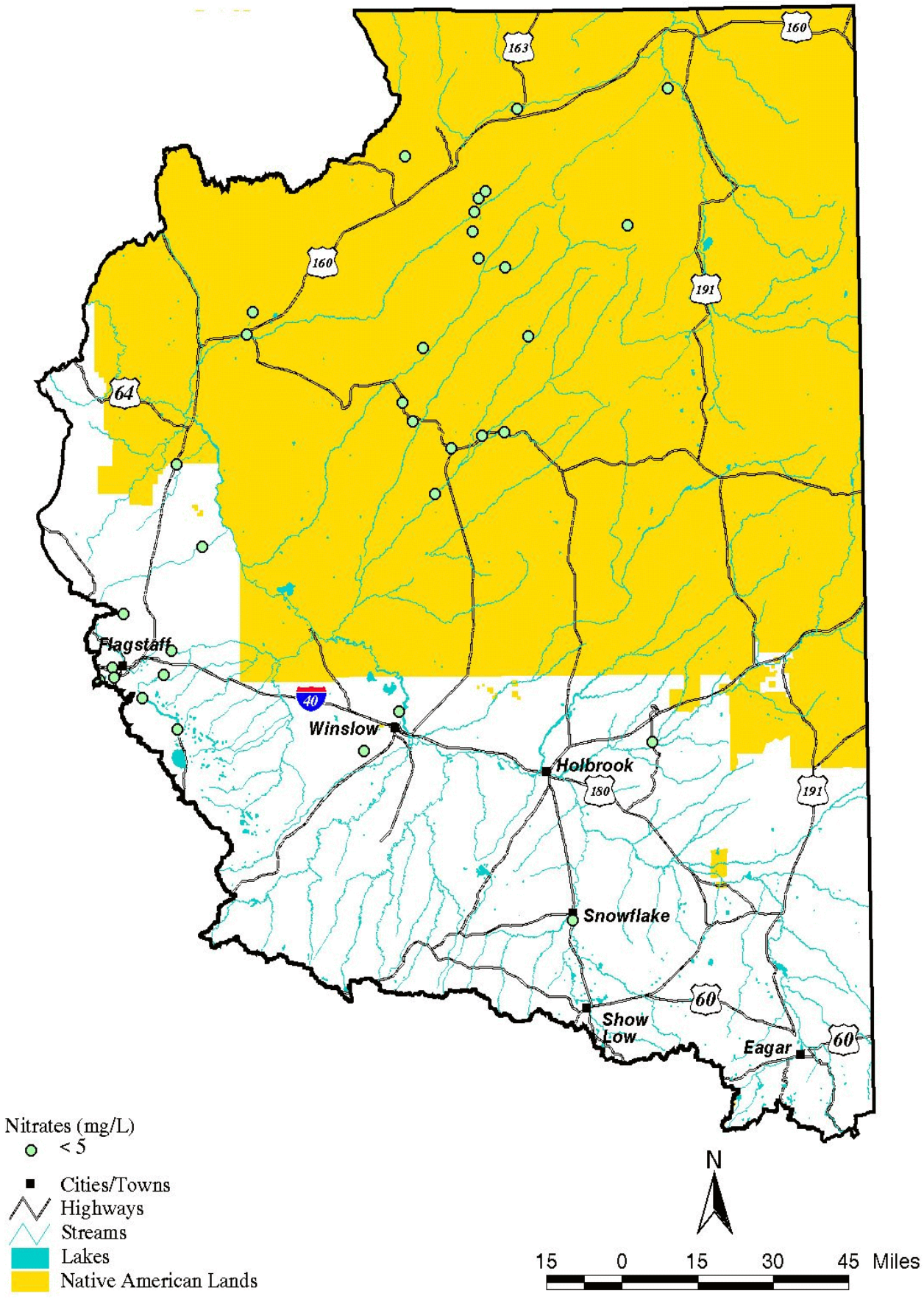
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Nitrates (mg/L)
< 5
Cities/Towns
Highways
Streams
Lakes
Native American Lands
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15 0 15 30 45 Miles

Watershed Studies and Alternative Solutions In the Little Colorado - San Juan Watershed

This section highlights surface and ground water studies, mitigation projects, and remediation activities which have been conducted to improve water quality in the Little Colorado-San Juan Watershed. Watershed partnerships active in this watershed are also mentioned.

Surface Water Studies and Mitigation Projects

Total Maximum Daily Load Analyses – The following TMDL analyses have been completed or are ongoing in this watershed. Further information about the status of these investigations can be obtained by contacting the TMDL Program manager at (602) 771-4468, or at ADEQ's web site: http://www.adeq.state.az.us/environ/water/assess/tmdl.html

- Nutrioso Creek TMDL – In 2000, EPA approved a Total Maximum Daily Load analysis on Nutrioso Creek for turbidity completed by ADEQ. The study determined that a seven mile section, extending from approximately two miles north of the Town of Nutrioso to Nelson Reservoir, violated the current turbidity standard of 10 NTU. Field investigations indicate that entrenchment and increased turbidity levels occurred primarily due to historic grazing and forestry practices in the watershed. Historic and current ungulate grazing has contributed to a loss of riparian vegetation which would help stabilize banks, dissipate stream energy, and slow stream velocities. The entrenchment of the stream caused a loss of flood plain, which leads to further increased stream velocity and related shear stress at bankfull and higher flows. The soils are primarily composed of a silty organic clay which are highly susceptible to waterborne erosion, freeze-thaw erosion, and wind erosion.

  The target load capacity for Nutrioso Creek to meet water quality standards during critical spring flows was calculated to be 183 pounds per day as total suspended solids (TSS), while the measured load was estimated to be 1020 pounds per day. Therefore, the load reduction Within the Rainbow Lake watershed there are no permitted point sources on nutrients; therefore, non-point sources must be controlled to eliminate harmful eutrophic conditions in Rainbow Lake. Several nonpoint sources of nutrients were identified: septic systems, ground water, decomposition of aquatic plants, and runoff from residential, commercial, agricultural, forests, and barren land. Based on historic was calculated to be 837 pounds of TSS per day. During average base flow conditions no load reduction is necessary as no violations occur.

  As turbidity impairment is correlated with increased flows in critical spring flow events, implementation projects and best management practices were designed reduce stream water velocities during these higher flows, and thereby, decrease sediment loads from sheet flow and wind erosion. A variety of Best Management Practices (BMPs) and other possible projects were identified in the TMDL, including:

  - Limiting cattle grazing in the riparian corridor to only the dormant winter months to encourage a diversity of emergent plants in the spring.
  - Reduced timber cutting on US Forest Service lands;
  - Close 40 miles of roads on US Forest Service lands (completed 1999);
  - Adjust cattle entry times and balance the number of cattle with the allowable use by 2005;
  - Establish cattle and wildlife exclosures where overgrazing has been a problem during critical growing periods;
  - Install stream grade stabilization structures to protect at risk banks during high critical flow events;
  - Encourage off-channel cattle and wildlife drinking facilities to allow more water to remain in the stream and allow the riparian corridor to encourage revegetation;
  - Revegetate riparian corridors with willow planting and grasses using a critical Area Planing method outlined by the Natural Resources Conservation Service guidance.

- Rainbow Lake TMDL – In 2000, EPA approved the Rainbow Lake nutrient TMDL for Rainbow Lake. Based on nutrient load reductions and projections for associated indicators, the standards for pH, ammonia toxicity, and narrative nutrients will be achieved.

  nutrient budgets the following load reductions from non-point sources are needed to achieve water quality standards (non-dredging option):

Nitrogen Reduction	**Phosphorus Reduction**
residential runoff – 50%	residential runoff – 50%
macrophyte decomposition – 50%	macrophyte decomposition 50%

septic systems – 75%

Implementation options were discussed in the TMDL. ADEQ recommended a strong monitoring effort in the lake and its tributaries to gauge the success of implemented strategies.

- Little Colorado River TMDL – ADEQ issued a draft turbidity TMDL for two segments of the upper Little Colorado River near Springerville, Arizona in May 2002. Investigations indicate that turbidity impairment actually starts upstream of these segments and that the main cause of turbidity is loss of vegetative cover due to historic and current grazing practices. The loss of vegetation, especially in the riparian area, allows increase runoff, soil erosion, and bank destabilization. Turbidity impairment appears to be correlated with larger flow events during winter-spring rain and snow melt and summer-fall monsoon rains. TMDL values were established for each season because of differences in flow regimes.

Turbidity is a measurement of light traveling through water. A loading cannot be calculated directly for this water quality standards; therefore, total suspended solids (TSS) were correlated to turbidity standards and measurements and were used to develop TSS load reductions.

Winter-spring : * At 29 cfs flow
TMDL = 1,702 pounds/day TSS
Load reduction 5,257 pounds/day TSS
Summer-Fall: * At 13 cfs flow
TMDL = 681 pounds/day TSS
Load reduction = 1,828 pounds/day TSS

Implementation projects and best management practices should be aimed at decreasing the contributions of sediment during higher flow events. Effective methods include increasing riparian vegetation, stream bank stabilization, maintenance of flood plains, and minimization of the impact of cattle in the general area.

Information about the status of this TMDL and opportunities for public involvement can be found at ADEQ's web site: http://www.adeq.state.az.us.

- A tamarisk and Russian olive tree removal demonstration project,
- Revegetation of native wetland and riparian species,
- Erosion control using straw bales,

Water Protection Fund projects – The following Water Protection Funds projects have been awarded grants by the Arizona Department of Water Resources.

- Saffell Canyon and Murray Basin (Sub-)Watershed Restoration Project – Apache Sitgreaves National Forest received this grant to restore watershed health and improve water quality water quality in these drainage areas by reducing and reversing soil erosion in the watershed. The Murray Basin and Saffell Canyon had been severely damaged by past management practices. Project was completed in 1998.

- Hoxworth Springs Riparian Restoration Project – Scientists at Northern Arizona University are working with the Coronado National Forest to restore the historic stream channel to a portion of a perennial stream that flows from Hoxworth Springs. The stream has experienced downcutting and a significant loss of riparian vegetation due to channelization and intense grazing from livestock and elk. Channel stabilization is to be accomplished using earth moving equipment and revegetation. Elk exclosures were constructed to reduce grazing pressure during restoration efforts. This project was completed in 1999.

- Highpoint Well Project – Navajo County Natural Resource Conservation District developed 24 water troughs and 3.5 miles of cross fencing to more evenly distribute grazing by livestock and wildlife (ungulates). The objective is to improve vegetative cover; thereby reducing erosion and sediment deposition in both Chevelon Creek and Clear Creek, which are perennial tributaries to the Little Colorado River. This project was completed in 1999.

- Talastima (Blue Canyon) Sub-watershed Restoration Project – The Hopi Tribe received funds to restore the Talastima subwatershed, which contains almost 8,000 acres with 19 miles of stream and wetlands on the Hopi lands. Restoration measures included:

- Completing livestock exclosures with fencing,
- Installation of a monitoring well and seven drive-point wells,
- A study of road impacts on riparian health.

Monitoring was conducted using on-the-ground data collection combined with remote sensing techniques to evaluate the success of tamarisk and Russian olive removal and revegetation to improve ground water levels, surface water flows, water quality, and migratory bird habitat. This project was completed in 2001

- Tsaile Creek (Sub-)Watershed Restoration Demonstration – The Navajo Nation received a grant to develop six watershed restoration projects with concurrent workshops to demonstrate riparian restoration concepts to local residents, tribal employees, and resource conservation professionals. The projects focused on biological restoration approaches and was completed in July 2000.

- Demonstration Enhancement of Pueblo Colorado Wash at Hubbell Trading Post – The National Park Service (Hubbell Trading Post National Historic Site) was funded to re-establish, enhance and conserve one-half file of the Pueblo Colorado Wash within the boundaries of this historic site. The stream channel was restored using low-tech instream structures to restore meanders and pools. This should slow stream flows so that sediment is deposited in point bars that will eventually support riparian vegetation. Invasive plant species were removed from the riparian area. The stream channel and riparian areas were revegetated with appropriate native species such as native reed, willows and cottonwoods. Restoration efforts and water quantity were evaluated to determine changes that result from project activities. Hydro-meteorological monitoring was conducted to establish hydrological baseline data for the wash. The project was completed in 2001.

- EC Bar Ranch Water Well Project – James Crosswhite, a rancher, received funds to develop an alternative water source for livestock and wildlife in order to eliminate the need for the animals to utilize a water gap in the fenced section of Nutrioso Creek, a degraded perennial stream. This objective will be met through the drilling of two water wells, installation of solar pumps, and distribution of water to tanks. The project is to be completed in 2002.

- Pressure Irrigation Feasibility Study and Preliminary Design – The Town of Eager and Round Valley Water Users Association received funds to conduct a feasibility study and preliminary design for making improvements to the irrigation system. Improvements to the irrigation system can potentially enhance the water quality and quantity of water in storage. Irrigation water is currently delivered through unlined open ditch canals, and extremely high water losses occur through percolation. These losses result in more water being diverted from the Little Colorado River. This study identified the extent of the water loss in the current irrigation ditch and canal system, and provided a preliminary design for the most feasible methods to resolve these water losses. Implementation of potential recommendations from this study could enhance riparian habitats along the Colorado River. (An ADEQ Water Quality Improvement Grant was also awarded to pipe the first five miles of the Big Ditch.) This project was completed in 2001.

- EC Bar Ranch Wildlife Drinker Project – Funds were also provided to James Crosswhite to establish four wildlife (elk) drinking water sources along the west and east sides of Nutrioso Creek in order to deter elk from using the creek and impacting the riparian vegetation. Livestock management of the area has recently been improved by the addition of upland water sources and livestock fencing. Livestock will continue to use the riparian area under a management plan formulated in conjunction of the Natural Resources Conservation Service. Project funding will be used to purchase and install conveyance pipe, drinkers, and more at four sites with water to be provided from a well previously developed using Water Protection Funds. The project is to be completed in 2003.

- Watershed restoration of a High Elevation Riparian Community – This project, conducted by Northern Arizona University, is to increase and sustain water flows into the unhealthy down slope riparian community at Hart Prairie in Northern Arizona. Previous riparian restoration work at this site improved moisture conditions by successfully increasing surface discharge and ground water storage; however, monitoring results indicate incomplete recovery due to up slope watershed conditions. The following work is aimed at improving water flows:

  - Reduce the density of pines encroaching the wet meadow by tree thinning and prescribed burns,
  - Construct fencing to manage grazing of large ungulates,
  - Reduce or eliminate stock tanks,
  - Restore stream channels in the upland watershed,
  - Continue and expand monitoring of the watershed vegetation, stream flow, and fluvial geomorphology.

- Little Colorado River Enhancement Demonstration Project – The Apache Natural Resources Conservation District was awarded funds to

develop a site-specific concept plan and construct a river restoration demonstration project on a reach of the upper Little Colorado River on private land. The project will incorporate a natural channel approach that will demonstrate an effective means for restoring a destabilized stream channel. The Upper Little Colorado River Partnership hopes to establish a demonstration project that will educate other landowners and natural resource managers about stream and riparian restoration techniques. This restoration project will be used as an outdoor classroom for looking at aquatic and riparian systems, biology , and domestic livestock and wildlife interactions. The projected is to be completed by 2003.

- Little Colorado River Riparian Restoration Project -- The Pueblo of Zuni seeks to restore a working riparian area and wetland ecosystem along the Little Colorado River in Hunt Valley. The project would involve testing and reconditions an existing well and constructing a pipeline to an areas that would restore three wetlands and 80 acres of riparian habitat. The tribe is committed to maintaining the project in perpetuity and has obtained matching funding from the US Bureau of Reclamation and the US EPA for monitoring efforts. This project is to be completed by 2003.

- Brown Creek Riparian Restoration – Apache-Sitgreaves National Forest Lakeside Ranger District received funds to establish one livestock watering facility, create a baseline inventory, and monitor a perennial segment of Brown Creek. The project area includes the spring and 1.5 miles of the upper portion of Brown Creek, one of a few perennial streams in this district.

Water Quality Improvement Grant Projects – ADEQ awarded the following Water Quality Improvement Grants (319h Grants) in this watershed.

- EC Bar Ranch Turbidity Reduction Project – Phase I and II – Jim Crosswhite, a private rancher, is to demonstrate the effectiveness of various practices recommended in the Nutrioso turbidity TMDL, such as adding riparian area fencing and installing off-channel water wells to remove cattle from riparian area. By doing this Mr. Crosswhite hopes to reestablish a properly functioning riparian corridor and eventually recondition Nutrioso Creek so that it meets its turbidity standard and TMDL goals.

- Overgaard Townsite Water Protection Project – The Overgaard Domestic Wastewater Improvement District plans protect surface and ground water that is presently threatened by an abandoned and failed onsite community wastewater disposal system. Twenty households are presently hooked up to the system, and when functioning, the system consists of a 10,000 gallon septic tank and leach field located on a one-acre parcel just north of the subdivision. Repair of the system is necessary to protect public health, the underlying ground water aquifers, and nearby streams.

- Murray Basin-Saffel Canyon Phase II -- The U.S. Forest Service is to improve two severely degraded areas in tributaries to Nutrioso Creek, by reducing current erosion processes and restore channels to their natural form and function. The Forest Service also plans to realign and upgrade some roads, obliterate some roads and two-track vehicle paths, and revegetate disturbed sites. The project will be implemented directly upstream of Nutrioso Creek, which is currently on the state's 303(d) List of impaired surface waters due to turbidity.
- Rogers Ranch Turbidity Reduction Project – This project focuses on reducing turbidity in Nutrioso Creek by restoring exposed stream banks and increasing vegetation growth using riparian fencing, off-channel water wells, and keeping water caps closed during the growing season.

- Upper Little Colorado River – Big Ditch Water Lass and Water Quality Improvement Project – Water on the Little Colorado River is diverted into the "Big Ditch" approximately six miles upstream of the town of Eagar. Eager plans to line the ditch with an impervious liner to cure the leakage now occurring in the ditch. This actions is to improve water quality by enhancing riparian growth and by increasing flows in the Little Colorado River.

Water Augmentation -- In 1999, researchers from the University of Arizona, with funding from the Arizona Rural Watershed Initiative, began water augmentation studies. Studies include looking at possible watershed management practices that might lead to increased runoff, and determining the feasibility of weather modification through precipitation patterns.

East Clear Creek Strategy Watershed Recovery Plan for the Little Colorado Spinedace and Other Riparian Species – This strategy was developed in coordination with various agencies responsible for managing habitat, activities, and wildlife resources to identify those activities that will assist in the recovery of the Little Colorado spinedace (a species federally listed as "threatened") and its habitat within the East Clear Creek drainage area. The strategy suggested management actions common to the entire watershed to substantially reduce both the direct and indirect impacts of recreation, roads, livestock and elk grazing, and

predatory aquatic species on the spinedace. These strategies will also benefit other riparian species. These strategies include:

- Remove or reduce introduced fish and crayfish;
- Survey spinedace locations, identify problems associated with recreation, road locations and use, livestock management, timber harvesting, and sport fish management, and develop solutions to these problems through the National Environmental Protection Act process.
- Provide supplemental stocking of Spinedace in perennial stretches to restore depleted populations;
- Pursue agreements and in-stream flow water rights to maintain stream flow in major tributaries and aqueducts; and ensure that the needs of aquatic species are considered in current and future water rights discussions.
- Manage elk and livestock to prevent degradation or improve meadows and riparian areas (e.g., exclosures, monitor watershed conditions, recommend population densities in line with natural habitat fluctuations due to rainfall).
- Take actions to restore and maintain riparian functioning condition and mimic historic flows (e.g., manage habitat for riparian species, planting and seeding, restrict or eliminate vehicles in meadows and riparian areas, reduce or eliminate camping in meadows);
- Evaluate roads and close/remove unneeded roads, relocate problem roads, and encourage the use of roads that do not negatively impact areas. Designate areas for off-road vehicles, and direct camping to specific areas.
- Educate and inform the public concerning these strategies.

The plan recommends specific actions for stream reaches and lakes within this drainage area and a prioritized implementation schedule. An annual report will evaluate whether actions are being accomplished and report on the effectiveness monitoring.

- To avoid ground water contamination, only alternative onsite wastewater treatment systems, designed by an engineer, should be used were the soil is rated as "unsuitable for use as a leach field" by the Natural Resources Conservation Service (shallow ground water). These systems must conform to ADEQ's Engineering Bulletin #12 and be approved for use by the county health department.
- Shallow perched aquifers (e.g. less than 15 feet below land surface, should be avoided as domestic water sources. Wells going through these perched aquifers should be properly sealed to exclude the entry of shallow or surface water.

This report was published in 1995. Further information can be obtained from

Further information concerning this report and strategy implementation can be obtained by contacting the US Fish and Wildlife Service or the Arizona Game and Fish Department.

Ground Water Studies and Mitigation Projects

Fort Valley Study -- ADEQ completed a ground water quality study in the small community of Fort Valley to look at possible impacts of septic systems on perched aquifers in the area. Samples were collected in 1993, 1994, and 1995 during varied climatic conditions – dry and wet seasons – to determine whether permanent or temporary ground water quality issues occurred due to septic systems.

From this study, ADEQ made the following conclusions and recommendations:

- The minimal extent of ground water contamination by septage-indicator parameters (e.g., nutrients, bacteria, total dissolved solids, chloride, sulfate) does not warrant recommending replacing currently installed septic systems with alternative wastewater disposal systems. However, caution should be exercised in selecting appropriate locations and types of additional systems and the operation of current systems.
- During periods of heavy precipitation, when ground water levels rise due to recharge, it would be prudent to dispose of wastewater by pumping septic tanks rather than allowing the septic effluent to possibly leach through saturate soil which would fail to provide proper filtration.
- It would be prudent for home owners to subject their septic tanks to a tightness test to determine if their septic systems were operating properly.

Douglas Towne at (602) 771-4412 or e-mail him at dct@ev.state.az.us.

Black Mesa Study – The Navajo Nation and Hopi Tribe of the Black Mesa area, Arizona depend on ground water to meet most tribal and industrial needs. Increasing use of this aquifer is creating concerns about adverse effects of withdrawals on the water resources of this region. The US Geological Survey (USGS) conducted a study of recharge rates and hydraulic conductivity of the aquifer to provide a conceptual model of ground water flow and to estimate recharge rates and hydraulic conductivity.

Adjusted radiocarbon data indicates that more than 90 percent of the water in the aquifer is older than 10,000 years and was recharged during glacial periods. In

some areas, the ground water was more than 35,000 years old. Hydrologic conductivities (movement of water in the soil) is estimated at from 0.05 to 2.1 feet per day, averaging 0.65 feet per day.

Copies of this investigation can be obtained from the USGS office in Tucson, Arizona (USGS Water Resources Investigation Report number 96-4190 -- Lopes and Hoffman, 1997).

Watershed Partnerships

Three watershed partnerships are working on water quantity and water quality concerns in the Little Colorado River-San Juan Watershed.

The Little Colorado River Multiple Objective Management (LCR-MOM) – This group uses a multi-objective management strategy which balances environmental and economic concerns to address all of this watershed's concerns -- flooding, sedimentation, stream form and function restoration, water conservation, recreation and tourism, irrigation systems and more. LCR-MOM provides an opportunity for citizens, businesses, and communities to establish a voluntary collaborative approach to enhancement of the quality of life within the watershed. It has identified the following major goals along with specific objectives and actions to accomplish each of them:

- Broaden people's knowledge of and involvement in the LCR-MOM planning process;
- Improve information and technology transfer on its resources;
- Sustain economic growth of the natural resources industry;
- Enhance the quality of live;
- Reduce risk and economic impacts from flood and other natural disasters;
- Water quality protection and improvement -- Improve surface water quality by:
  a. reducing stream bank erosion;
  b. coordinating restoration and enhancement efforts;
  c. providing alternative wildlife and stock water sources;
  d. extend sewer infrastructure to outlying areas, eventually eliminating septic tanks and leach fields to improve ground water quality;
  e. evaluate the use of treated sewage effluent for pasture, golf courses, wildlife habitat, etc;
  f. evaluate the feasibility of combining the sewage collection and treatment systems of Springerville and Eager; and
  g. evaluate the feasibility of silt removal from Lyman Lake and sediment storage on Coyote Creek.
- Increase proper function characteristics of the river systems;
- Enhance recreational opportunities;
- Preserve the cultural heritage;
- Maintain and improve water quality for all uses;
- Increase opportunities for conservation and multiple use of water resources;
- Improve watershed and stream function to promote diverse, stable, and productive wildlife and fish habitat; and
- Enhance networking among individuals, agencies, and organizations with an interest in this watershed.

The LCR-MOM holds regularly scheduled workshops and meetings. To obtain further information you can contact a representative at (520) 524-6063, extension 5 or http://www.littlecolorado.org.

The Upper Little Colorado River Watershed Partnership – The partnership has identified the following as goals:

- Water quantity conservation -- Conserve surface and ground water by:
  a. improving irrigation efficiency through replacing open ditches with lined channels and pipes, minimizing irrigation water run-off;
  b. evaluate the use of low water use crops where possible; and
  c. evaluate the possibility of water augmentation through watershed management and weather modification, both winter snow and summer rain.
- Conserve ground water resources -- Substitute surface water for ground water, where possible, to help maintain and eventually raise ground water levels. Quantify ground water levels and pumping. continue monitoring pumping, ground water levels, and drawdown.
- Land and resource conservation – Encourage the continued implementation of various conservation measures such as:
  a. Improve grazing management practices such that the watershed will sustain natural vegetation, thus improving habitat and water quality. This includes fencing to improve grazing management and providing off-stream drinking water facilities for wildlife and livestock;
  b. Install erosion and sediment control structures where needed;
  c. Develop proper timber management practices including small diameter logging to increase water yield, maintain a continuous supply of wood fiber and reduce erosion, prevent wildfires through "controlled burning" practices.
  d. Protect and enhance threatened and endangered species habitat; protect and enhance habitat for wildlife and flora; protect and develop

wetlands;

e. Evaluate and develop recreational opportunities (fishing hunting, access to surface waters, wildlife viewing, and trails for hiking, equestrian, and off-road vehicles).

· Public Outreach -- Hold meeting to make the public aware of activities and future projects. Develop a web site. Support a local education center and develop demonstration areas and outdoor classrooms.

A steering committee is composed of local communities, water user groups, the Hopi Tribe, Apache County, and local citizens with technical support from state and federal agencies.

The Nutrioso Creek Watershed Partnership – This work group was formed in 1998 to provide oversight for implementation projects and plans, and may provide additional data in the form of volunteer monitoring of Nutrioso Creek. This partnership is officially represented at the Upper Little Colorado River Watershed Partnership meetings. This work group maintains a website with information about the 319 funded projects on Nutrioso Creek at Jim Crosswhite's E.C. Bar Ranch at: http://www.ecbarranch.com/. This website also provides information about grant writing, funding sources, and more that may be useful to other partnerships.